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DESCRIPTION OF *ALPHEUS BELLULUS* SP. NOV. ASSOCIATED
WITH GOBIES FROM JAPAN
(CRUSTACEA, DECAPODA, ALPHEIDAE)¹⁾

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With 2 Text-figures

During the visit of the first author, Y. MIYA, to the Seto Marine Biological Laboratory, Kyoto University in the summer of 1967 he was compelled attention to Dr. Eiji HARADA's story of an association of a snapping shrimp with gobies, on which Dr. HARADA was then making observations. According to HARADA's informations, that snapping shrimp occurred commonly associated with some gobies in burrows on the sandy bottom of shallow sublittoral areas near the Laboratory and Ezura about 1 km east from there in Tanabe Bay. MIYA had not enough time to make his own observations on this association and to collect that snapping shrimp, but Dr. HARADA kindly offered him three specimens of the shrimp for identification. On examination of these specimens it was found that the shrimp was a species of the *brevirostris* group, apparently new to science.

Recently another specimen of the same species was found unexpectedly in a small collection of decapod crustaceans from Kagoshima Bay, which was presented to the present authors through the courtesy of Dr. Toshio SAISHO. The specimen was collected by Dr. Kantaro NAKAHARA, who kindly informed the authors on inquiry that the specimen was found living in association with a goby in shallow water of Kaminose in Kagoshima Bay as in the case of HARADA's observations and submitted them his records of field observations.

The present paper is restricted to the taxonomical description of this new species including its colouration in life. The ecological notes of the species, such as habitat and distribution, associated occurrence of the snapping shrimp and gobioid fishes, burrowing behaviour, and interspecific relationships, will be fully discussed upon sufficient data by Dr. HARADA in the next article of this number (Publ. Seto Mar. Biol. Lab., XVI (5) 315-334, 1969).

The holotype is deposited at the museum of the Seto Marine Biological Laboratory

1) Contributions from the Zoological Laboratory, Faculty of Agriculture, Kyushu University, No. 394 and Contributions from the Seto Marine Biological Laboratory, No. 499.

(SMBL Type No. 226) and the paratypes in the collection of the Zoological Laboratory, Faculty of Agriculture, Kyushu University (ZLKU).

This study was made possible through the courtesy of the following persons who submitted the material and the records of field observations to the authors: Dr. Eiji HARADA, Biological Laboratory, Yoshida College, Kyoto University; Dr. Kantaro NAKAHARA, Sakurajima Aquarium; Dr. Toshio SAISHO, Zoological Laboratory, Faculty of Fisheries, Kagoshima University. The authors wish to express also their gratitude to Prof. Huzio UTINOMI, Dr. Takasi TOKIOKA and Mr. Chûichi ARAGA, Seto Marine Biological Laboratory, Kyoto University, for their interest and encouragement in this study.

Alpheus bellulus sp. nov.

(Japanese name: Nishiki teppo-ebi)

(Text-figs. 1 and 2)

Type specimens. Holotype: Male (13.2 mm in carapace length), SMBL Type No. 226, ZLKU No. 12177, burrowing on gravelly sand flat of 5 m deep, Ezura, Tanabe Bay, Wakayama Prefecture, August 8, 1967, E. HARADA leg. Paratypes: An ovigerous female (17.2 mm in c.l.) and a male (anterior half of carapace only), ZLKU No. 12178, burrowing on gravelly sand flat of 3–5 m deep, near S.M.B.L., Tanabe Bay, Wakayama Pref., August 9, 1967, E. HARADA leg; a female (17.8 mm in c.l.), ZLKU No. 11432, burrowing on gravelly sand flat in a huge tide pool, Kaminose, Kagoshima Bay, Kagoshima Pref., August 1967, K. NAKAHARA leg.

Diagnosis. Rostrum equilateral triangular, its blunt apex reaching almost to the end of first antennular segment; rostral carina sharp, extending posteriorly beyond the base of orbital hoods, in lateral view it is markedly higher than orbital hood which is moderately inflated.

Antennular peduncle slender, second segment 2.4–2.6 times as long as broad; stylocerite reaching forward as far as rostral apex. Carpocerite almost reaching to the tip of antennular peduncle; scaphocerite with strong lateral spine markedly extending beyond the anterior margin of lamella, which reaches forward as far as the tip of antennular peduncle.

Large chela marked with a transverse groove near the articulation of movable finger (dactylus). Small chela without such a groove; fingers high, shutting together, not excavated internally; movable finger usual in female, while balaeniceps-shaped in male.

Carpal joints of second pereiopod with ratio, 10:10–11:4:4:5.

In third pereiopod dactylus spatulate instead of styliform; merus unarmed, 3.7 to 4.0 times as long as broad.

Description of holotype. The animal is stout; the carapace and abdomen are hard and sparsely furnished with short bristles (Text-fig. 1). The rostrum in dorsal view is

equilateral triangular with margins curving gradually to merge with the anterior margins of the orbital hoods which are moderately inflated; its blunt apex reaches almost to the end of the first antennular segment; its dorsal carina is sharp, in lateral view markedly higher than the orbital hood and attaining to the anterior fourth of the carapace; the orbitorostral groove is shallow and V-shaped (Text-fig. 2, B). The pterygostomial margin is rounded.

The antennular peduncle is narrow, the second segment 2.4 times as long as broad; the stylocerite is apically pointed, reaching forward as far as the rostral apex. The basicerite of the antenna bears a strong spine; the carpocerite is three times as long as broad, almost reaching to the tip of the antennular peduncle; the scaphocerite possesses the strong lateral spine largely exceeding the anterior margin of the lamella which is broad and reaches forward as far as the tip of the antennular peduncle.

The third maxilliped is stout and extends beyond the tip of the antennular peduncle by the distal third of its ultimate segment, whose end is truncate and with a tuft of long hairs; the penultimate segment is furnished with several long hairs on the inner ventral margin; the antepenultimate segment is serrated on the ventral margin.

The large chela is strongly compressed, 2.4 times as long as high; the inner surface is minutely granulated on the palmar portion, while the outer surface is smooth; the dorsal margin is fringed with a row of long hairs both on the inner side of the whole length and on the outer side of the palmar portion only; the ventral margin also has the fringe of long hairs on the inner side. The movable finger is shorter than two-thirds of the length of the palm which is 1.5 times as long as high; there is a deep transverse groove near the base of the movable finger. The carpus is conical. The merus is 2.2 times as long as broad; the ventral inner margin is coarsely serrated, with long hairs and two movable spines, and apically subacute. The ischium is also coarsely serrated on the ventral inner margin.

The small chela is 2.4 times as long as high, strongly compressed, and smooth on the entire surface except for on the inner surface of the palmar portion which is slightly granulated; the dorsal and ventral margins of the chela are fringed with two rows and one row of long hairs, respectively, as in the large chela. Both fingers (movable one distally broken) are not excavated internally, shutting together, and 1.3 times the length of the palm which is as long as high; there is a row of short plumose hairs on each surface of both fingers (balaeniceps-shaped). The carpus, merus and ischium are similar to those of the large cheliped.

The second pereopod extends beyond the tip of the antennular peduncle by the chela and carpus; the carpal joints have a ratio, 10:11:4:4:5.

The third pereopod exceeds the anterior margin of the carapace by the length of dactylus, propodus and carpus; the dactylus is broad and spatulate, bearing several short bristles on the lateral margins; the propodus has nine spines on the ventral margin and coarse hairs on the outer and inner surfaces; the carpus and merus are unarmed, the latter 3.7 times as long as broad; the ischium has a movable spine. The

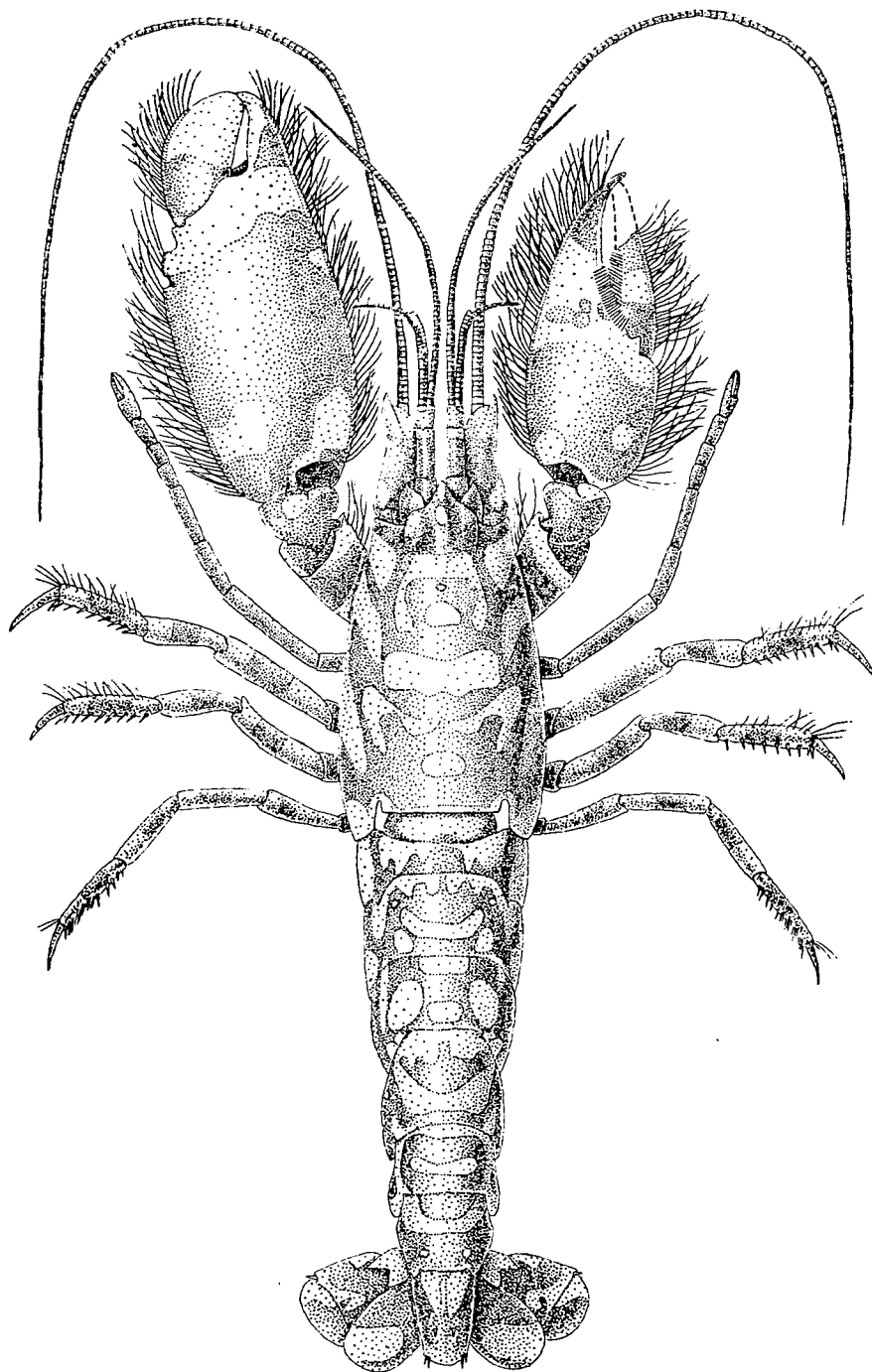
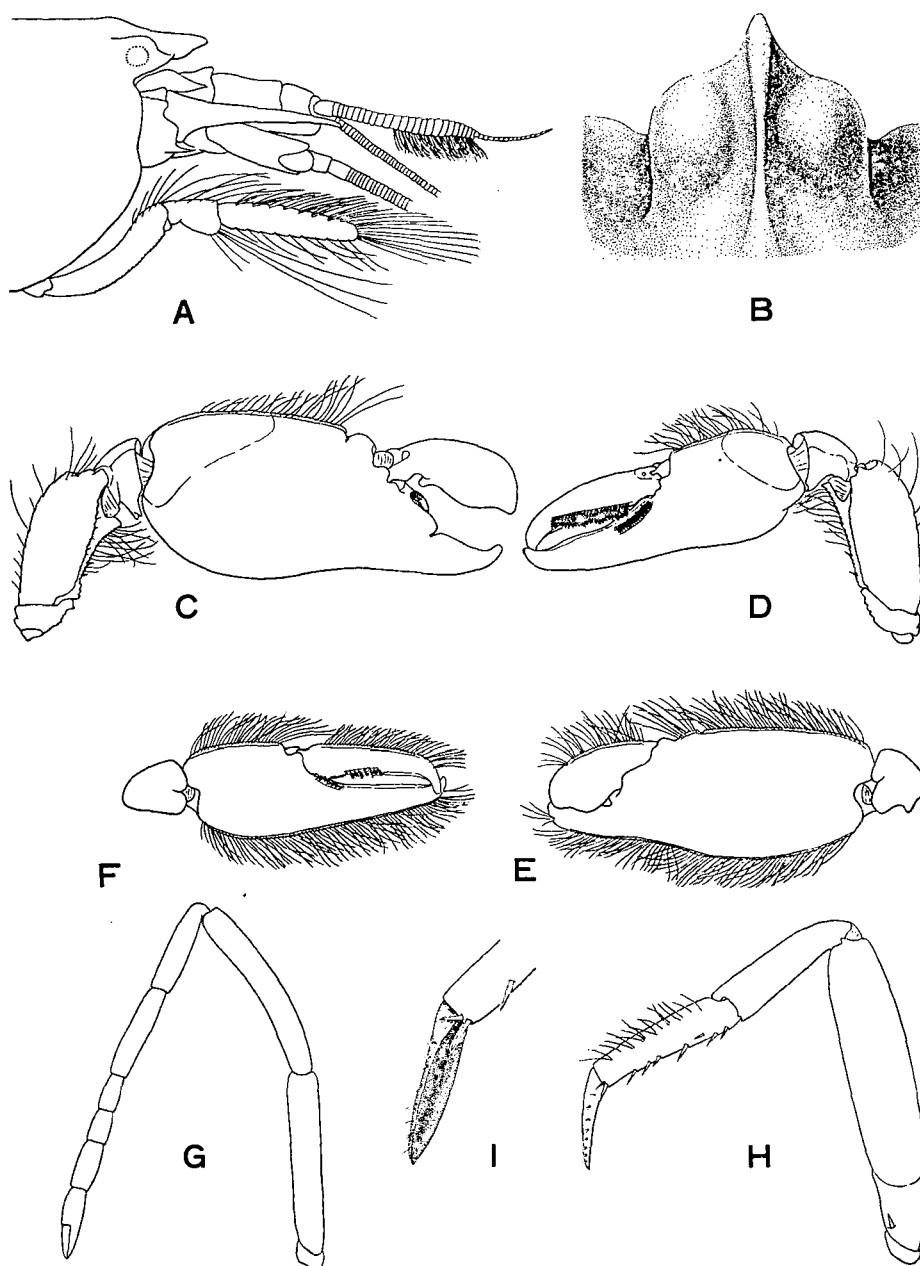


Fig. 1. *Alpheus bellulus* sp. nov., holotype, male, $\times 3$.

Fig. 2. *Alpheus bellulus* sp. nov.

A, Anterior part of paratype male in lateral view, $\times 4.5$; B, anterior part of holotype in dorsal view, $\times 9$; C, large cheliped (right) of paratype male in outer view, $\times 2.5$; D, small cheliped (left) of paratype male in outer view, $\times 2.5$; E, large chela (right) of paratype ovigerous female in inner view, $\times 2.5$; F, small chela (left) of paratype ovigerous female in inner view, $\times 2.5$; G, left second pereopod of paratype male, $\times 4.5$; H, left third pereopod of paratype male, $\times 4.5$; I, dactylus of left third pereopod of paratype male in obliquely outer view, $\times 9$.

following two pereopods are closely allied to the third one; in the fifth pereopod the outer surface of the propodus possesses rows of short bristles.

The telson is 2.5 times as long as broad at the posterior margin which is strongly arcuate and has a pair of spines on each corner; there are two pairs of dorsal spines, the anterior pair is situated before the middle, the posterior pair is on the distal third of the length.

Description of paratypes. A male specimen is in such a poor condition as only the anterior half of carapace and the first three pereopods are available (Text-fig. 2, A, C, D, G-I).

Two female specimens are in a good condition and show the same characters as in males except for the following points in the first pair of pereopods: In the large chela the dorsal margin of the palm of both females possesses the transverse groove which is less conspicuous than in males; fingers of the small chela of the non-ovigerous female (No. 11432) are without hairs at the basal part of each surface, while those of the ovigerous female (No. 12178) are furnished with plumose hairs, which, however, are

Table 1. Measurements of body and appendages in mm.

	Holotype		Paratypes	
	♂, No. 12177	ovig. ♀, No. 12178	♂, No. 12179	♀, No. 11432
Total length	36.9	47.2	—	52.6
Carapace length	13.2	17.2	11.0+	17.8
Telson,				
length	4.8	5.1	—	6.0
length to breadth at posterior margin	2.5	2.5	—	2.3
Large cheliped,				
length of dactylus	7.0	6.5	7.2	6.2
length of palm	10.9	9.9	10.9	10.0
height of palm	7.5	6.3	7.9	6.9
length of merus	6.7	7.9	7.0	8.7
breadth of merus	3.0	3.0	3.0	3.0
Small cheliped,				
length of dactylus	5.7+	7.6	7.9	7.9
length of palm	5.6	5.5	5.9	5.1
height of palm	5.6	4.7	5.4	4.8
length of merus	7.0	8.0	7.9	9.0
breadth of merus	3.1	3.1	3.5	3.3
Second pereopod,				
relative dimensions of carpal joints	10:11:4:4:5	10:11:4:4:5	10:10:4:4:5	10:10:3:3:5
Third pereopod,				
length of dactylus	2.7	3.0	3.0	3.0
length of propodus	4.1	4.5	4.3	5.1
length of merus	7.0	8.0	7.4	8.9
breadth of merus	1.9	2.0	1.9	2.3

implanted fewer than in males (Text-fig. 2, E, F).

Paratypes agree quite well with the holotype, but there are slight proportional differences in segment length, breadth and height of some appendages as seen in measurements (Table 1).

Colour in life. The ground colour of the entire animal may be expressed as yellowish white or yellow. On the carapace, abdomen and tail fan, there is an irregular bright brownish purple pattern which encloses a number of yellowish white patches of variable shapes arranged symmetrically. The proximal two-thirds of antennular peduncle and of scaphocerite and the whole of carpocerite are also brownish purple. The antennular and antennal flagella are vermillion. The ultimate segment of the third maxilliped has a broad band of bluish purple and ends in a tuft of vermillion hairs; the penultimate segment is yellowish white and with a tuft of vermillion hairs; and the antepenultimate segment is tinged with bluish purple.

In the large cheliped, the distal half of each finger is pure white, but the proximal half is brownish or bluish purple; the palm is brownish purple on the inner surface, verging to bluish purple on the outer surface; the dorsal and ventral margins of chela are fringed with yellow hairs; the carpus is brownish purple; the merus has a broad band of bluish purple on the middle, which is proximally fading away into yellowish white; the ischium is yellowish white. The small cheliped has the same colouration as in the large cheliped, except that the distal half of each finger is bluish purple.

In the second pereopod the chela and carpus are bluish purple, there is a band of the same colour on the central half of the merus and ischium. The last three pereopods are clearly marked with a broad band of bluish purple on the central half of propodus, carpus, merus and ischium; the dactylus and the remaining part of the propodus seem yellow rather than yellowish white. The pleopods are white and fringed with vermillion hairs.

The eggs are yellowish brown.

Relationship. The present form belongs evidently to the group of the species in which (1) the large chela is furnished with a transverse groove near the base of movable finger, while the small chela without this groove, (2) in the small chela fingers are not gaping and (3) the movable finger is balaeniceps-shaped in the male, and (4) the merus of the third pereopod is unarmed. However, it differs from *Alpheus savuensis* DE MAN, 1908, *A. djiboutensis* DE MAN, 1909, *A. platyunguiculatus* (BANNER, 1953) and *A. cythereus* BANNER and BANNER, 1966 principally in the appearance of the anterior part of the carapace. In *A. bellulus* sp. nov. the rostrum is blunt and equilateral triangular, and in lateral view its dorsal carina is markedly higher than the orbital hood; whereas the rostrum is acute and slender, and in lateral view its dorsal carina is much lower and concealed behind the orbital hood in *A. savuensis*, *A. djiboutensis* and *A. platyunguiculatus*, or higher than the orbital hood only slightly in *A. cythereus*. There is a supplementary character distinguishing the respective members of the group from one another, i.e. the ratio of carpal joints of the second pereopod: 10:10-11:4:4:5 in *A. bellulus* sp. nov.,

10:14-15:6:6:6 in *A. savuensis*,¹⁾ 10:7:3:3:4 in *A. djiboutensis*,²⁾ 10:23:7:10:11 in *A. platyunguiculatus* and 10:15:5:5:6 in *A. cythereus*. In addition, the new species is distinguished from *A. savuensis* by the dactyli of the last three pereopods which are spatulate instead of styliform and the shorter carpocerite in the former, and from *A. djiboutensis* by the broader merus of the third pereopod and the broader telson in the former, and from *A. platyunguiculatus* and *A. cythereus* by the form of chelae of the first pereopods and the shorter carpocerite in the new species.

Further, *A. bellulus* sp. nov. is closely allied to "*Alpheus* species 3" from Saipan of the Mariana Archipelago (BANNER, 1965). According to BANNER, "*Alpheus* species 3" is based on a male specimen in a poor condition and shows a closer relationship to *A. savuensis*. *A. bellulus* sp. nov. is, however, readily separated from "*Alpheus* species 3" by the shorter rostral carina, the large chela fringed with long hairs on the dorsal and ventral margins, and the shorter carpocerite in the former.

Ecology. On this subject refer to the detailed report of HARADA (1969). NAKAHARA's field observations made in Kagoshima Bay on the habitat, burrowing behaviour and the association of this shrimp with a goby, *Amblyeleotris japonicus* TAKAGI, are exactly the same as the HARADA's made in Tanabe Bay.

Distribution. Tanabe Bay, Wakayama Prefecture (type locality) and Kagoshima Bay, Kagoshima Prefecture. In addition to these localities this species was found living in shallow water of Ushibuka on Amakusa-jima, west off Middle Kyushu.³⁾

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- 1) The ratio of carpal joints was calculated on the described lengths or measured on the figure (DE MAN, 1911, p. 393; 1915, pl. 20, fig. 90d).
- 2) The ratio bases upon the original description and figure.
- 3) According to Mr. ARAGA (HARADA, 1969), the snapping shrimp was also found by underwater observation on the similar bottom in the fringing areas of rocky reefs of Ushibuka in September 1967.